

# The “dark side” of Industry 4.0: How to make technology more sustainable?

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## **Purpose**

Recent literature has identified several positive sustainability performance impacts of Industry 4.0 technologies in manufacturing companies. Some authors suggest that new technologies such as Internet of Things, sensors, and big data analytics can facilitate waste reduction and monitor manufacturing energy consumption, leading to energy savings (Bai et al., 2020). In contrast, a few studies have already identified various tradeoffs for some aspects of environmental and social sustainability dimensions. For example, scholars indicate that a fully automated production could lead to higher primary resource consumption, and cloud technologies could produce the loss of employees’ autonomy due to continuous data sharing used for decision making. Nevertheless, empirical research on the negative sustainability effects of Industry 4.0 is still scarce and anecdotal (Beltrami et al., 2021).

Thus, the goals of this study are: (1) to identify the possible negative impacts of the new digital technologies (e.g., autonomous robots, cloud technologies, Internet of Things, and additive manufacturing) on firms’ environmental and social sustainability aspects; (2) to highlight the motivations and mechanisms behind them; and (3) to identify possible firm-level corrective actions that companies might implement to mitigate these negative effects.

## **Methodology**

A Delphi study involving 43 international experts from academia and industry has been conducted. Experts have been asked to evaluate the likelihood and severity of each statement and provide additional comments justifying the rationale and the presence of mitigating actions.

## **Findings**

Findings contribute to extant knowledge by identifying and describing various negative impacts of Industry 4.0 technologies on sustainability performance while providing the main mechanisms behind them. Moreover, experts' insights highlight various corrective actions to counteract the Industry 4.0 adverse effects illustrated. For instance, as suggested by the surveyed experts, firms can prevent a possible increase in the production of waste electrical and electronic equipment due to the implementation of Industry 4.0 wireless technologies by developing recycling and circular economy initiatives and increasing the durability of the components using long-term oriented technologies.

## **Practical implications**

This study can be relevant for managers who oversee the implementation of Industry 4.0 technologies. The corrective actions proposed can be valuable for practitioners and company managers to avoid digital technologies' adverse effects in their work practice.

## **Contribution**

Research findings encourage researchers to further investigate the “dark side” of Industry 4.0 by developing qualitative and quantitative research studies, completing a detailed description of this relevant issue and providing further insights to facilitate a sustainable Industry 4.0 technologies' implementation.

**Keywords:** Industry 4.0, Sustainability, Delphi study

## References

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